

Claim Objections

The USPTO objected to a number of claims based on various language in the claims. The applicants have amended the claims consistent with the suggestions of the Examiner. Note, however, that the phrase, "which is", has been inserted in Claims 23 and 26 rather than merely the word, "is", as the applicants believe that this language is more accurate.

Listing of the Claims

Claim 1. (Currently amended) A catalyst for use in stationary or fluid bed dehydrogenation processes for converting hydrocarbons to olefins ~~and / or~~ and/or diolefins, said catalyst comprising:

a carrier; chromium, in the form of Cr_2O_3 , at a concentration from about 10 wt% to about 30 wt%, based on the total catalyst weight, ~~including the Cr_2O_3~~ ; zirconium, as a promoter, in the form of ZrO_2 , at a concentration from about 0.1 wt% to about 15 wt% zirconium based on the total catalyst weight, ~~including the ZrO_2~~ , and magnesium, as a promoter, in the form of MgO , at a concentration from about 0.1 wt% to about 15 wt% magnesium, based on the total catalyst weight, ~~including the MgO~~ .

Claim 2. (Original) The catalyst of Claim 1 wherein the carrier is selected from a group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, alumina-silica, silica, silicates, zeolites, bayerite, gibbsite, nordstrandite and combinations thereof.

Claim 3. (Original) The catalyst of Claim 1 wherein the carrier has a surface area of from about $15 \text{ m}^2/\text{g}$ to about $300 \text{ m}^2/\text{g}$, a pore volume of from about 0.2 cc/g to about 1.5 cc/g , and an average pore diameter of from about 3 nm to about 30 nm.

Claim 4. (Original) The catalyst of Claim 1 wherein the carrier has a particle size of from about 20 μm to about 150 μm .

Claim 5. (Original) The catalyst of Claim 1 wherein the carrier comprises an alumina carrier that is spray-dried or pelletized and calcined at from about 500°C to about 1100°C.

Claim 6. (Currently amended) The catalyst of Claim 1 wherein the chromium promoter is derived from a member selected from the group consisting of CrO_3 , inorganic chromium salts, ~~including~~ ammonium chromate, ammonium dichromate, ~~and~~ chromium nitrate, organic chromium salts, and combinations thereof.

Claim 7. (Currently amended) The catalyst of Claim 1 wherein the chromium promoter is present in the form of Cr_2O_3 at a concentration from about 15 wt% to about 28 wt%, based on the total catalyst weight, ~~including the Cr_2O_3 .~~

Claim 8. (Original) The catalyst of Claim 1 wherein the chromium promoter is added in the form of a CrO_3 solution that is impregnated onto the alumina carrier.

Claim 9. (Currently amended) The catalyst of Claim 1 wherein the zirconium promoter is present in the form of ZrO_2 at a concentration of from about 0.1 wt% to about 5 wt%, based on the total catalyst weight, ~~including the ZrO_2 .~~

10. (Currently amended) The catalyst of Claim 1 wherein the zirconium promoter is present in the form of ZrO_2 at a concentration of from about 0.5 wt% to about 1.5 wt%, based on the

total catalyst weight, ~~including the ZrO_2 .~~

Claim 11. (Original) The catalyst of Claim 1 wherein the zirconium promoter is co-impregnated on the carrier with the chromium promoter.

Claim 12. (Currently amended) The catalyst of Claim 1 wherein the magnesium promoter is present in the form of MgO at a concentration from about 0.1 to about 2 wt%, based on the total catalyst weight, ~~including the MgO .~~

Claim 13. (Original) The catalyst of Claim 1 further comprising from about 0.3 to about 2 wt%, based on the total catalyst weight, of an alkali metal promoter, expressed in the form of an alkali metal oxide.

Claim 14. (Original) The catalyst of Claim 1 further comprising at least one additional promoter selected from the group consisting of scandium, yttrium, lanthanum, titanium, hafnium and combinations thereof.

15. (Currently amended) A dehydrogenation catalyst comprising:
a carrier selected from the group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, bayerite, gibbsite, nordstrandite, alumina-silica, silica, silicates, zeolites and combinations thereof, having a surface area from about 15 m^2/g to about 300 m^2/g , a pore

volume from about 0.2 cc/g to about 1.5 cc/g, and an average pore diameter from about 3 nm to about 30 nm; chromium, as a promoter, ~~in the form of~~ calculated as Cr_2O_3 , at a concentration from about 15 wt% to about 28 wt%, based on the total catalyst weight, ~~including the~~ Cr_2O_3 , wherein the chromium is derived from a member selected from the group consisting of CrO_3 , ammonium chromate, ammonium dichromate, chromium nitrate, organic chromium salts, other inorganic chromium salts, and combinations thereof; zirconium as a promoter, calculated as ZrO_2 , at a concentration from about 0.1 wt% to about 5 wt% zirconium, based on the total catalyst weight, ~~including the~~ ZrO ; and magnesium as a promoter, calculated as MgO , at a concentration from about 0.1 to about 2 wt%, based on the total catalyst weight ~~including the~~ MgO .

Claim 16. (Currently amended) The catalyst of Claim 15 wherein the chromium promoter is present at a concentration from about 17 wt% to about 24 wt%, based on the total catalyst weight, ~~including the~~ Cr_2O_3 .

Claim 17. (Original) The catalyst of Claim 15 wherein the chromium is added in the form of a CrO_3 solution that is impregnated onto the alumina carrier.

Claim 18. (Currently amended) The catalyst of Claim 15 wherein the zirconium promoter in the form of ZrO_2 is present at a concentration from about 0.5 wt% to about 1.5 wt%, based on the total catalyst weight, ~~including the ZrO_2 .~~

Claim 19. (Currently amended) The catalyst of Claim 15 wherein the magnesium promoter in the form of MgO is present at a concentration from about 0.5 to about 1 wt%, based on the total catalyst weight, ~~including the MgO .~~

Claim 20. (Original) The catalyst of Claim 15 wherein the zirconium is co-impregnated on the carrier with the chromium and the magnesium.

Claim 21. (Original) The catalyst of Claim 15 further comprising from about 0.3 to about 2 wt%, based on the total catalyst weight, of an alkali metal promoter, expressed in the form of an alkali metal oxide.

Claim 22. (Original) The catalyst of Claim 15 further comprising at least one promoter selected from the group consisting of scandium, yttrium, lanthanum, titanium, hafnium and combinations thereof.

Claim 23. (Currently amended) The catalyst of Claim 15 which is used for dehydrogenation in a stationary or fluid bed.

Claim 24. (Currently amended) A dehydrogenation catalyst comprising:

a carrier, selected from the group consisting of aluminum

oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, bayerite, gibbsite, nordstrandite, alumina-silica, silica, silicates, zeolites and combinations thereof, and having a surface area from about 15 m²/g to about 300 m²/g, a pore volume from about 0.25 cc/g to about 0.35 cc/g, and an average pore diameter from about 3 nm to about 30 nm, wherein said carrier is spray-dried or pelletized and calcined;

chromium, as a promoter, ~~in the form of~~ calculated as Cr₂O₃, at a concentration from about 17 wt% to about 24 wt%, based on the total catalyst weight, ~~including the Cr₂O₃~~ wherein said chromium is derived from a member selected from the group consisting of CrO₃, ammonium chromate, ammonium dichromate, chromium nitrate, organic chromium salts, other inorganic chromium salts, and combinations thereof, wherein said chromium is added to the support in the form of a CrO₃ solution that is impregnated onto the carrier;

an alkali metal, as a promoter, calculated as an alkali metal oxide, at a concentration from about 0.3 wt% to about 2 wt%, based on the catalyst weight, ~~including the alkali metal oxide~~;

zirconium, as a promoter, calculated as ZrO₂, at a

concentration from about 0.5 wt% to about 1.5 wt% zirconium, based on the total catalyst weight, ~~including the ZrO_2~~ ; and magnesium, ~~as~~ as a promoter, calculated as MgO , at a concentration from about 0.5 wt% to about 1 wt% magnesium, wherein the magnesium is co-impregnated on the carrier with the chromium and zirconium.

Claim 25. (Original) The catalyst of Claim 24 further comprising at least one promoter selected from the group consisting of scandium, yttrium, lanthanum, titanium, hafnium and combinations thereof.

Claim 26. (Currently amended) The catalyst of Claim 24 which is used for dehydrogenation in a stationary or fluid bed.

Claim 27. (Currently amended) The catalyst of Claim 24 wherein the alkali metal promoter comprises about 0.3 to about 1 wt% Na_2O , based on the total catalyst weight, ~~including the Na_2O~~ .